Stoichiometry Study Worksheet (Also review textbook questions and your notes)

1. Why must masses of reactants or products, in a balanced chemical equation, be converted to moles before the quantities can be compared? Use any concept or definition of the mole.

[ 3 marks ]

2. Based upon your understanding of the combustion of hydrocarbons, explain what by-products are likely to form if oxygen is the limiting reactant, particularly for long-chain organic molecules. [ 2 marks ]

3. Calculate the mass of solid nickel (II) phosphate formed when 8.5 grams of aqueous nickel (II) chloride reacts with excess sodium phosphate. (Begin with a balanced chemical equation.) [ 5 marks ]

4. A balanced equation for the production of copper from copper ore is as follows:

2 Cu2O(s) + Cu2S(s) → 6 Cu(s) + SO2(g)

When 250 kg copper (I) oxide is heated with 129 kg copper (I) sulphide, 285 kg of copper is recovered.

a) Identify the limiting reactant. [ 5 marks ]

b) Calculate the theoretical yield of copper. [ 3 marks ]

c) Calculate the percentage yield of the reaction. [1 mark ]

5. Equal masses of nitrogen dioxide and water react according to:

3 NO2(g) + H2O(l) → 2 HNO3(aq) + NO(g)

Which reagent is in excess, and what percentage of it will remain at the end of the reaction?

Answers:

1. Both mass and moles convey information about quantity of substance, but moles allow direct comparison of the number of atoms/molecules reacting with one another, the ratio or proportion of which is expressed by the coefficients of the balanced equation. Mass measurements give us no information about how many relative particles are reacting with one another.

2. If oxygen is the limiting reactant, particularly when combusting larger hydrocarbon molecules, a likely by-product is carbon monoxide, which is a smog-related pollutant and is dangerous to human health, as well as unreacted carbon. When performing combustion, oxygen gas should be in the excess.

3. Equation: 3 NiCl2(aq) + 2 Na3PO4(aq) → Ni3(PO4)2(s) + 6 NaCl(aq)

Mass Ni3(PO4)2 formed = 8.0 grams

4. a) (First convert kg to g)

# moles Cu2O = 1,750 mol; # moles Cu2S = 810 mol

Cu2O produces 5,240 mol Cu; Cu2S produces 4,860 mol Cu

Therefore, Cu2S is limiting

b) Theoretical yield of Cu = 309 kg

c) Percent yield = 92.2% (or 92% for 2 sig digs)

5. Assume e.g. 10 grams of each reactant. Use this to find number of moles of NO.

NO2 produces 0.0724 mol NO ; H2O produces 0.5552 mol NO

Therefore NO2 is limiting, and H2O is in excess.

Number of moles of H2O left unreacted is 0.4828 mol = 8.695 grams

Percent left over = 8.695/10.0 = 87% H2O is left unreacted at end of the reaction.